Supporting Remote Guidance through 3D Annotations

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ABSTRACT
Remote guidance enables untrained users to solve complex tasks with the help of experts. These tasks often include the positioning of physical objects to certain poses. The expert indicates the final pose to the user. Therefore, the quality of annotations majorly influences the success of the remote collaboration.
This work compares two kinds of annotation methods (2D and 3D) in two scenarios of different complexity. A pilot study indicates that 3D annotations reduce the execution time of the user in the complex scenario.

Author Keywords
augmented reality; 3D annotation; collaboration.

ACM Classification Keywords
H.5.2 Information Interfaces and Presentation: User Interfaces—*Interaction styles*;

INTRODUCTION
Possible annotation types for remote guidance can be characterized by pointers, 2D annotations and 3D annotations. Currently, no work compares the effectiveness of 2D versus 3D annotations. We created two different scenarios: The first scenario includes planar positioning tasks, whereas the second scenario is in 3D. Both scenarios have to be solved by a novice, who receives either 2D or 3D annotations from a remote expert.
Annotation Concepts: The differences of the two annotation concepts can be classified according to [1].
Dimensionality: The main difference between the two annotation types: 2D and 3D.
View-point reference frame: In case of 2D sketches, the expert's view matches the egocentric viewpoint of the mobile user. For the 3D annotations, the mobile user keeps the egocentric viewpoint. However, the expert is able to move an additional, independent virtual camera. This way, the expert has an egocentric viewpoint, too.
Mounting and registration: Only the expert is authorized to create annotations. The 2D sketches are human-mounted since the positions depend on the mobile device, which is grasped by the novice. The 3D annotations are fixed to the 3D world. The expert manipulates the predefined, virtual 3D models through keyboard.

SUI'14, October 4–5, 2014, Honolulu, HI, USA.
ACM 978-1-4503-2820-3/14/10.
http://dx.doi.org/10.1145/2659766.2661206

STUDY & RESULTS
The novices hold a 11.6" mobile PC. The expert works on a stationary 22.8" touch monitor. The subjects communicate only by voice and the selected annotation type. Each subject performs the study with one annotation type.
Scenarios: Each participant has to place six physical objects per scenario.
Simple scenario: Subjects of the 2D placement scenario arrange objects to a connected geometrical shape. This scenario is constrained by the assumption that all objects reside on a common surface. Translation and rotation each only have 2 DoF, leading to a total of 4 DoF.
Complex scenario: This scenario has no limitations regarding translation and rotation. The physical objects can be freely rotated and translated.
Results: We conducted a pilot study with one expert and six subjects. Important times for this kind of task are the execution time of the worker T^w and the interaction time of the expert T^e. Both times are visible in Figure 1. T^e of the 2D

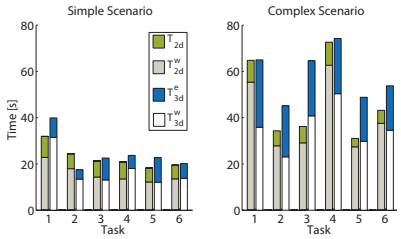

Figure 1. The times for the simple (left) and complex (right) scenarios.

sketches is almost the same in both scenarios. The 3D annotations need more time (T^e_{3d}) in the complex scenario than in the simple scenario. In the simple scenario, T^e_{2d} and T^e_{3d} do not vary much.
In the complex setting, 4 of 6 execution times T^w_{3d} are shorter than T^w_{2d}. This indicates that 3D annotations are beneficial for complex tasks and similar to 2D sketches for easier tasks.

ACKNOWLEDGMENTS
The research leading to these inventions has received funding from the European Union Seventh Framework Programm (FP7/2007-2013) under grant agreement n° 284573.

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REFERENCES
1. Tönnis, M., Plecher, D. A., and Klinker, G. Survey Representing Information - Classifying the Augmented Reality Presentation Space. *Comput. Graph. 37*, 8 (2013), 997–1011.